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ABSTRACT

The SUCCEED coalition, one of the NSF Engineering Education Coalitions, was founded on a vision in which all engineering graduates will possess not only highly developed technical skills, but also the attitudes and awareness needed to prosper in the contemporary workplace. This vision manifested itself within SUCCEED by the development of curriculum innovations for undergraduate engineering education. These innovations were introduced on an experimental basis initially at the member campuses with the long term intention of subsequently exporting successful ones beyond the coalition membership. This paper presents findings from a qualitative evaluation of the first five years of operation of the SUCCEED coalition. During this time, SUCCEED was engaged in start-up activities and experimentation with various approaches to curricular reform. During the first five years, the coalition's primary goal was to implement, evaluate, and disseminate Curriculum 21, which was not a prescribed sequence of courses but a statement of principles for undergraduate education. Among these principles were the integration of engineering with other subjects, the enhancement of performance skills, the infusion of engineering practice into coursework, the provision of multidisciplinary team experiences, and the incorporation of information and communications technology into the classroom. Along with curriculum reform, SUCCEED was also committed to three other goals: adopting Total Quality Management principles on a coalition-wide basis; increasing retention rates, especially among women and students from underrepresented minority groups; and promoting outreach to secondary schools and community colleges. This paper reflects the findings of an ongoing evaluation of the first through fifth years of the coalition's existence. In it, we show that SUCCEED made substantial, but incomplete progress toward the accomplishment of its goals. Much progress was made toward curriculum reform especially in the areas of increased access to technology, early exposure to engineering, horizontal integration of coursework, vertical integration, and real-world work skills. Questions remain as to whether these successful programs can be institutionalized and exported to other campuses. There is also an ongoing concern about the institutional rewards structure as it relates to participation in educational reform initiatives, particularly at the large, research-oriented institutions in the coalition. This paper should benefit those who are considering forming a similar coalition as well as those who might be called upon to evaluate its success. (Author)

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Growing Pains: An Evaluation of the SUCCEED Coalition

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Abstract *- The SUCCEED coalition, one of the NSF Engineering Education Coalitions, was founded on a vision in which all engineering graduates will possess not only highly developed technical skills, but also the attitudes and awareness needed to prosper in the contemporary workplace. This vision manifested itself within SUCCEED by the development of curriculum innovations for undergraduate engineering education. These innovations were introduced on an experimental basis initially at the member campuses with the long term intention of subsequently exporting successful ones beyond the coalition membership. This paper presents findings from a qualitative evaluation of the first five years of operation of the SUCCEED coalition. During this time, SUCCEED was engaged in start-up activities and experimentation with various approaches to curricular reform.*

During the first five years, the coalition's primary goal was to implement, evaluate, and disseminate Curriculum 21, which was not a prescribed sequence of courses but a statement of principles for undergraduate education. Among these principles were the integration of engineering with other subjects, the enhancement of performance skills, the infusion of engineering practice into coursework, the provision of multidisciplinary team experiences, and the incorporation of information and communications technology into the classroom. Along with curriculum reform, SUCCEED was also committed to three other goals: adopting Total Quality Management principles on a coalition-wide basis; increasing retention rates, especially among women and students from underrepresented minority groups; and promoting outreach to secondary schools and community colleges.

This paper reflects the findings of an ongoing evaluation of the first through fifth years of the coalition's existence. In it, we show that SUCCEED made substantial, but incomplete progress toward the accomplishment of its goals. Much progress was made toward curriculum reform especially in the areas of increased access to technology, early exposure to engineering, horizontal integration of coursework, vertical integration, and real-world work skills. Questions remain as to whether these successful programs can be institutionalized and exported to other campuses. There is also an ongoing concern about the institutional rewards structure as it relates to participation in educational reform initiatives, particularly at the large, research-oriented institutions in the coalition. This paper should benefit those who are considering forming a similar coalition as well as those who might be called upon to evaluate its success.

Introduction

Founded in 1992, the SUCCEED (Southeastern Universities and Colleges Coalition for Engineering EDucation) coalition was formed with a goal of improving undergraduate engineering education at its member campuses and ultimately at other colleges of engineering in the US. The coalition consists of eight member institutions geographically concentrated in the Southeastern part of the US, ranging in size from very large to relatively small, and with diverse institutional missions. During the first five years, the coalition's primary goal was to implement, evaluate, and disseminate Curriculum 21, which was not a prescribed sequence of courses but a statement of principles for undergraduate education. Among these principles were the integration of engineering with other subjects, the enhancement of performance skills, the infusion of engineering practice into coursework, the provision of multidisciplinary team experiences, and the incorporation of information and communications technology into the classroom. Along with curriculum reform, SUCCEED was also committed to three other goals: adopting Total Quality Management principles on a coalition-wide basis; increasing retention rates, especially among women and students from underrepresented minority groups; and promoting outreach to secondary schools and community colleges.

This paper primarily reflects the findings of an 18 month qualitative evaluation of SUCCEED during its third and fourth years of operation. The purpose of the evaluation was to determine how well SUCCEED was progressing toward meeting the above goals. We will briefly describe

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the methods employed in assessing the coalition and then report SUCCEED's accomplishments and shortcomings as it moves into its second five year funding cycle.

Methods

Between November, 1994 and April, 1996, we visited each member campus to conduct our evaluation. In all, we interviewed roughly 175 individuals for this study, including campus and SUCCEED administrators, faculty and non-teaching staff members, graduate research and teaching assistants, current undergraduate students, recent graduates, and workplace mentors/supervisors. Most faculty and staff interviewees were Principal Investigators (PIs) or other major participants in one or more SUCCEED-funded projects. In general, the interviews with PIs focused on their own projects and on their overall reactions to participating in SUCCEED. Upon request, many of the PIs also identified students who had participated in their projects. The administrator interviews were especially useful in detailing the history of SUCCEED at each site and in providing insights into the broader financial and managerial issues confronting the coalition as a whole.

Beyond interviewing participants, we also examined documents pertaining to the implementation and impact of SUCCEED on each campus. These included the proposals and annual reports of the SUCCEED coalition and of individual projects, as well as a variety of research papers, syllabi, courseware, and other artifacts. In addition, we visited classrooms, laboratories and offices and witnessed (and occasionally participated in) displays of the innovative technology developed under SUCCEED sponsorship. We were also able to sit in on portions of the informal site visits conducted by representatives of the National Science Foundation, and have participated in all of SUCCEED's annual conferences to date, where we attended paper sessions and workshops, examined poster sessions, and spoke informally but usefully to several dozen individuals.

Findings

Our overall finding is that by the end of the first five years of operation, SUCCEED had made substantial but incomplete progress toward the achievement of its goals. On the positive side, SUCCEED made considerable strides in the area of curriculum reform. In addition, a favorable climate for reform had been fostered, in part by legitimizing classroom research with outside funding, and in part because the coalition truly operated as such. SUCCEED did less well in the areas of outreach to women, minorities, and students at feeder institutions; there were also some problems with project funding. Data are not yet available to assess progress of student retention efforts and there is an ongoing concern about the institutional rewards structure as it relates to participation in educational reform initiatives. We will now address each of these areas in more detail.

Accomplishments

Although SUCCEED has attracted only about one-fifth of the coalition's combined engineering faculties (approximately 300 people) to its cause, it has registered some substantial accomplishments in the area of curriculum reform, including the following:

- *Access to technology.* Some theorists believe that expanded use of technology is one of the most effective means by which American higher education can promote equality of opportunity while upholding academic quality standards. This is an area where the overall performance of SUCCEED projects appears to have exceeded initial expectations. In the words of one informant, "SUCCEED and the other coalitions have started off a whole new area for using multimedia in education. They've seeded the area and [the growth that has occurred] couldn't have happened without them." Key contributors include not only those projects whose mission is multimedia development and electronic connectivity, but also those courses that routinely make coursewares available on CD-ROMs or on the World Wide Web.
- *Early exposure to engineering.* Freshman engineering labs, based on Curriculum 21 and quality principles, have already been institutionalized at several coalition sites. More generally, interviews with students suggest that providing access to engineering content early in their undergraduate careers may help to reinforce the initial choice of an engineering major. This apparently happens by providing concrete experiences that either support or expand students' previous notions of what it means to be an engineer.
- *Horizontal integration.* Cross-disciplinary courses, involving the integration of engineering with humanities, mathematics, and the natural and social sciences, exist at nearly every SUCCEED site.
- *Vertical integration* was manifested in courses that encourage repeated enrollments and/or collaboration between newcomers and advanced engineering students. Younger students could then learn how concepts are applied even though they did not yet possess the technical expertise to do it themselves.
- *Teamwork, "real world" problem-solving, and diffusion of responsibility.* In contrast to the relatively passive role that students have traditionally played, a number of SUCCEED projects effectively diffused significant responsibilities for goal attainment to students. This is true of both team-oriented courses and problem solving projects. Indeed, a theme emerging from our interviews with students was the great satisfaction that many had found in the opportunities for leadership and initiative

that were available in SUCCEED courses and projects. This experience is valued not only as a means of personal development but, more concretely, as valuable preparation for the engineering workplace.

Another basis for optimism that emerges from the evaluation is that SUCCEED has functioned as a true coalition of institutions in that it has established the means by which ideas and materials that are successfully tested at one site can be rapidly disseminated to other member institutions, and from there to the wider public. The emphasis on diffusion means that the fate of an innovation does not depend on the sustained enthusiasm of faculty or administrators at any single site. Also, reform minded faculty at one institution found like-minded peers in other departments within their institutions and at other institutions within the coalition. This gave them confidence that they were not the only ones interested in good teaching and provided a peer support network for their reform initiatives.

Many principal investigators and some administrators indicated that instructional improvement was a lower priority for their institutions than demonstrated success in research. This was particularly true of the larger Research I institutions. The reason has little to do with an innate preference for research or with contempt for teaching, as some critics of higher education claim (e.g., [1]). Rather, the explanation lies in the academic reward structure and ultimately in the economics of contemporary higher education. In the prevailing view, research generates more external resources (money and prestige) than does teaching and is thus rewarded accordingly [2]. One of our positive findings was that by providing research grants for classroom research, SUCCEED legitimized research on teaching methods, improving its status to some extent in the faculty rewards process. For example, one benchmark of SUCCEED's impact was the value of articles published in engineering education journals, which, according to several interviewees, had typically been about one-third of the comparative worth of publications in engineering research outlets. Thanks in part to SUCCEED, this ratio was said to have risen to approximately one-half or two-thirds. However, in spite of this progress in a few individual cases, there is little indication that there has been a fundamental restructuring of the faculty reward system at the member institutions.

Shortcomings

Although SUCCEED made substantial progress in a number of areas, as with any ambitious reform program, there were areas where it failed to achieve its goals. This happened primarily in outreach to various groups - women, underrepresented minorities [3], and students in primary school, secondary school, and community colleges [4] (K-14 outreach). Another shortcoming was the untimely distribution of funds to the project PIs.

Outreach

With respect to outreach to women and minorities, in spite of some successful programs, notably summer programs directed at incoming minority freshmen, there was a feeling expressed by those involved that programs targeted to women and minorities were marginalized within the coalition. This feeling of marginality extended to the historically black institutions within the coalition which tended to receive less funding for their activities and felt that their project proposals were disproportionately rejected.

In order to gain an understanding of issues related to minority groups, interviews were conducted with student participants and staff members of the Minority Retention program at each of the eight SUCCEED sites. Built in part around programs already in place before the inception of SUCCEED, the "Minority Retention Megaproject" consisted of summer and year-round activities designed to ease the transition from high school to college. In most instances, the participants were African-American freshmen, though a substantial number of Hispanic freshmen participated at some sites.

On all campuses, students spoke favorably about their involvement in the program, and were able to identify some of the specific benefits derived, including close personal contacts with staff and other students, enhanced study skills, and improved academic performance. Some of those who had participated as freshmen returned to serve as counselors or mentors during succeeding years.

Interviews with project staff and examination of records pertaining to student retention and academic performance generally confirmed the impression of program effectiveness. Overall, the conclusion is that these programs create a positive initial contact between new students and the world of engineering education by helping to reduce students' anxieties and bolstering self-confidence.

These accomplishments notwithstanding, interviewees at a number of sites expressed concerns about the Minority Retention Megaproject's relationship to SUCCEED. Of particular importance was the process by which SUCCEED decided to initiate funding to certain campuses more rapidly than others. There also appeared to be considerable uncertainty as to whether future funding levels would be sufficient to sustain program activities. Finally, several informants spoke of a sense that minority issues should not be confined to any one program but needed to be addressed more forthrightly by SUCCEED as a whole.

Our primary source of information about women's issues came from in-person interviews with the campus representative to the Women's Engineering Board (WEB), some of which others provided extensive information not only about WEB but about factors bearing on the retention of female students. According to these informants, WEB

has pursued two primary goals: First, to promote networking and mentoring among female faculty and students at SUCCEED institutions and second, to improve the climate of engineering education generally on SUCCEED campuses, thereby raising the overall rate of student retention.

One area that appears to require further attention is WEB's relationship to SUCCEED. Echoing the sense of marginality raised by those involved in minority programs, there was also a sense that WEB was "disconnected" from the mainstream of SUCCEED interests. Several interviewees suggested that student retention should be a priority for all SUCCEED projects, not just those charged with reaching out to specific groups. The most important constraints in this area were identified as the comparative lack of visibility for women within SUCCEED and its member institutions and the need for additional funding.

Only two SUCCEED institutions made any substantial effort in the area of K-14 outreach. One of them had a relationship with a local high school whereby they provided student mentors during the school year, a two week summer workshop for female middle and high school students, and participated with the high school in a national engineering design competition. The other school offered a one week summer transition program to students transferring into upper division engineering classes from community colleges. Although both programs were successful, they were not adopted elsewhere in the coalition and remained outside of the mainstream.

Funding

SUCCEED, like the other NSF Engineering Education Coalitions, is designed to function as a grassroots organization, whose energy and ideas originate at the local level. At the same time, however, it is financially dependent on NSF, which prefers not to deal with individual projects but with a single coalition-wide leadership group. These complex linkages among NSF, the coalition leaders, the projects, and the participating institutions have sometimes resulted in lengthy delays in processing awards, leading to widespread dissatisfaction among PIs, and to the disruption of some activities. Clearly, management issues such as these should be taken into account in any process or product evaluation. Yet it is often difficult to identify the specific sources of these problems or to recommend feasible solutions. For example, consider that the availability of funds is tied to the federal fiscal year, which begins on October 1. Sometime after that date, the money arrives at coalition headquarters, where it must be processed by the Contracts and Grants office, and then separately disbursed to the other institutions, and then eventually to the projects. This process is not normally completed until late winter or spring. Meanwhile, the projects themselves operate on the academic calendar, which, in the Southeast, begins in mid-August. Although the host institutions have generally been willing to advance funds to the project against which expenses can be charged, such has not always been the case, especially in the hiring of graduate assistants. Indeed, we found that the frustration and uncertainty surrounding these procedures to be by far the single largest source of dissatisfaction among participants.

Conclusions

During its first five years, SUCCEED made creditable progress toward meeting its goals, particularly in the area of curricular reform. Hard data are not yet available to determine if these curriculum enhancements have improved retention and graduation rates of undergraduate students at the participating institutions, but our qualitative data indicated that they have. In spite of the problems inherent in managing a multi-institution entity, particularly in the area of fund disbursement, coalition leaders have done a commendable job of leading SUCCEED toward its ultimate goal of sustainable curriculum reform on its member campuses and disseminating its successful practices beyond the coalition. The growing pains encountered during its first five years, and the positive reactions to them, should make the coalition stronger and more successful during its next five years.

For more information about the inception of SUCCEED, its foundations and early goals, see: C. Zorowski and T. Brown "Lessons Learned from Operating and NSF Engineering Education Coalition" in these proceedings. Other information about SUCCEED may be found on the World Wide Web at http://www.succeed.vt.edu.

References

[1] Fairweather, J. *Faculty work and public trust*. Boston: Allyn and Bacon. 1996.

[2] Clark, B. *The higher education system*. Berkeley: University of California Press. 1983.

[3] In undergraduate engineering education in the United States, underrepresented minorities tends to refer to African Americans, Native Americans, and persons of Hispanic origin.

[4] In the United States, community colleges are postsecondary institutions which, among other things, provide the first two years of undergraduate instruction. Students who successfully complete the two year program may transfer to four year institutions to complete their bachelor's degree work.